CLAIMS

What is claimed is:

1. A method of verifying cold start emissions reduction control in an internal combustion engine, comprising:

measuring engine speed;

determining a commanded ignition timing of said engine;

determining an actual energy flow based on said measured engine speed and said commanded ignition timing;

determining an energy flow residual based on said actual energy flow and an expected energy flow;

assigning a system quality weight to said energy residual based on predetermined operating conditions;

accumulating a plurality of said weighted energy residuals over a predetermined time;

determining an average engine-out energy flow based on said accumulated weighted energy residual and accumulated system quality weight;

filtering said average engine-out energy flow;

comparing said filtered average engine-out energy flow with a predetermined acceptable range; and

generating a signal based on said comparison.

2. The method of claim 1 wherein determining an actual energy flow comprises:

determining an actual thermal energy potential per unit mass based on said commanded ignition timing;

determining an actual thermal mass flow based on said measured engine speed; and

calculating a product of said actual thermal energy potential and said thermal mass flow.

3. The method of claim 2 further comprising:

calculating an expected energy flow by:

determining a designed thermal mass flow based on a designed engine speed;

determining a designed thermal energy potential based on designed ignition timing; and

calculating a product of said designed thermal mass flow and said designed thermal energy potential.

4. The method of claim 1 wherein determining an energy flow residual comprises:

calculating a difference between said actual energy flow and said expected energy flow.

5. The method of claim 1 wherein assigning a weight comprises:

determining if a throttle position is within a predetermined range;

determining if an intake mass airflow is within a predetermined range;

determining if a vehicle speed is within a predetermined range;

determining if a coolant temperature is within a predetermined range; determining if said engine is running within a predetermined run time; and

calculating the product of all weights defining a system quality weight based on said determinations.

6. The method of claim 1 wherein determining an average engine-out energy flow comprises:

assigning a system quality weight to said energy flow residual based on predetermined operating conditions;

accumulating a plurality of said system quality weights over a predetermined time;

accumulating a plurality of said weighted energy residuals over a predetermined time; and

determining an average engine-out energy flow based on said accumulated weighted energy residual and said accumulated weight.

7. The method of claim 6 wherein accumulating a plurality of said weights includes calculating the sum of each system quality weight over predetermined time.

8. The method of claim 6 wherein accumulating a plurality of said weighted energy residuals includes calculating the sum of the product of each energy residual and respective system quality weight over said predetermined time.

9. A method of verifying cold start emissions reduction control in an internal combustion engine, comprising:

measuring engine speed;

determining a commanded ignition timing of said engine;

determining an actual energy flow based on said measured engine speed and said commanded ignition timing;

determining an expected energy flow based on designed engine speed and designed ignition timing calibrations;

determining an energy flow residual based on said actual energy flow and said expected energy flow;

determining a filtered average engine-out energy flow residual based on an accumulation of said energy flow residuals over a predetermined time;

comparing said filtered average engine-out energy flow residual with a predetermined acceptable range; and

generating a signal based on said comparison.

10. The method of claim 9 wherein determining an actual energy flow comprises:

determining an actual thermal energy based on said commanded ignition timing;

determining an actual thermal mass flow based on said measured engine speed; and

calculating a product of said actual thermal energy and said thermal mass flow.

11. The method of claim 9 wherein determining an expected energy flow comprises:

determining a designed thermal mass flow based on a designed engine speed;

determining a designed thermal energy potential based on designed ignition timing; and

calculating a product of said designed thermal mass flow and said designed thermal energy potential.

12. The method of claim 9 wherein determining an energy flow residual comprises:

calculating a difference between said actual energy flow and said expected energy flow.

13. The method of claim 9 wherein determining a filtered average engine-out energy flow comprises:

assigning a system quality weight to said energy flow residual based on predetermined operating conditions;

accumulating a plurality of said system quality weights over a predetermined time;

accumulating a plurality of said weighted energy residuals over a predetermined time;

determining an average engine-out energy flow based on said accumulated weighted energy residual and said accumulated system quality weight; and

filtering said average engine-out energy flow.

14. The method of claim 13 wherein accumulating a plurality of said weights includes calculating the sum of each system quality weight over a predetermined time.

15. The method of claim 13 wherein accumulating a plurality of said weighted energy residuals includes calculating the sum of the product of each energy residual and respective system quality weight over said predetermined time.

16. The method of claim 13 wherein determining an average engine-out energy flow comprises:

calculating said accumulated weighted energy residual divided by said accumulated system quality weight.

17. The method of claim 13 wherein assigning a weight comprises:

determining if a throttle position is within a predetermined range;

determining if an intake mass airflow is within a predetermined range;

determining if a vehicle speed is within a predetermined range;

determining if a coolant temperature is within a predetermined range;

determining if said engine is running within a predetermined run time; and

calculating the product of all weights defining a system quality weight based on said determinations.

18. A method of verifying cold start emissions reduction control in an internal combustion engine, comprising:

measuring engine speed;

determining a commanded ignition timing of said engine;

determining an actual energy flow by:

determining an actual thermal energy based on said commanded ignition timing;

determining an actual thermal mass flow based on said measured engine speed; and

calculating a product of said actual thermal energy and said thermal mass flow;

determining an expected energy flow by:

determining a designed thermal mass flow based on a designed engine speed;

determining a designed thermal energy potential based on designed ignition timing; and

calculating a product of said designed thermal mass flow and said designed thermal energy potential;

determining an energy residual by:

calculating a difference between said actual energy flow and said expected energy flow;

assigning a weight to said energy residual based on predetermined operating conditions;

accumulating a plurality of said weighted energy residuals over a predetermined time;

accumulating a plurality of said weights over a predetermined time;

determining an average engine-out energy flow based on said accumulated weighted energy residual and said accumulated weight;

filtering said average engine-out energy flow; and

comparing said filtered average engine-out energy flow with a predetermined acceptable range; and

generating a signal based on said comparison.